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# Development of a Peduncle Belt as a Medium to Long-Term Tag Attachment Platform for Cetacean Studies

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## LONG-TERM GOALS

To develop a recoverable, noninvasive medium to long-term tag attachment platform which would enable detailed data sets to be collected over extended periods of time (multiple days to multiple months) and would aid in understanding natural whale behaviors and assessing anthropogenic impacts on vulnerable populations.

## OBJECTIVES

- To develop a peduncle style tag and tag deployment system as a means of attaching medium to long-term tags to free swimming whales. Two different systems are currently under development:
    1) a pole deployed peduncle saddle pack tag for mid-sized whales
    2) a net gun deployed towed telemetry buoy for large whales

- To demonstrate the potential of the peduncle style tag as a benign medium to long-term, noninvasive tag attachment platform either through field trials or in a captive animal setting.

## APPROACH

*Peduncle saddle pack tag*
A padded harness will fit around the tail stock of the whale at the narrowest portion of the peduncle just before the fluke insertion point. To deploy the belt, a cantilevered pole mounted on the bow of a small inflatable will drop a spring loaded armature on the caudal terminus of the whale (Figure 1). Once triggered, the armature's sickle shaped arms will close, latching a buckle under the whale's belly. As the arms lift away, the elasticized belt is cinched to snugly secure the semi-rigid saddle housing the tag electronics to the dorsal ridge of the peduncle. An electronic timed release combined with a backup

# Report Documentation Page

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14. ABSTRACT
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15. SUBJECT TERMS

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corrosive galvanic release form a redundant release system for reliably removing the harness and tag system at a pre-set time. A breakaway link will also be included to minimize entanglement risk and ensure that the belt releases from the whale should the harness become fouled on any gear or other debris in the water.

*Net gun deployed towed telemetry buoy*
Woodward *et al.* (2006) developed a novel net gun deployment system and towed satellite telemetry tag as a part of a NOAA/NMFS sponsored grant. The regular net used with the CODA gun was replaced with a custom designed 24 ft x 20 ft open rectangular lasso with a trailing line running back to the tagging boat. One pound cylindrical weights are attached to each of the lasso's four corners and loaded into the four barrels of the gun using an o-ring seal. The net gun uses a blank .308 cartridge to propel the weights out of its four barrels, and the splay of the gun barrels ensures that the corners of the lasso are widely spread to fully deploy the loop. Tests in the harbor using the deck mounted net gun system demonstrated an 80% lassoing success rate on a full-scale fiberglass model right whale tail (Figure 2). Once the lasso clears the fluke tips, the forward motion of the whale away from the tag boat will close the lasso down to a 10 ft padded section. As the whale moves away, a rope ascension module will push the buoy up the line until it reaches a stop, at which point it will trim the trailing tether and leave the buoy trailing the whale at a distance of 60ft. Similarly to the peduncle saddle pack tag, multiple redundant release systems (electronic timed release, galvanic timed release, breakaway link, and low strength biodegradable tow line) are incorporated in the harness to ensure that the harness releases from the whale allowing the whale to go gear free should a problem arise.

System designs will be done in-house at Woods Hole Oceanographic Institution. B. Woodward will lead the project working with J. Winn to design, fabricate and test the two tagging systems. M. Moore will provide veterinary expertise, advising during the tag development process and evaluating potential impacts of the tag once in the field.

## WORK COMPLETED

- Continued the development of a peduncle saddle pack tag and deployment armature
    - Designed & fabricated Rev 4 of the deployment armature - a pneumatic $CO_2$ powered horizontally mounted piston which enacts a pliers-like closing of sickle shaped arms
    - Molded a pilot whale peduncle section from a cadaver for use in saddle pack design for mid-sized whales
    - Designed & fabricated Rev 2 prototypes of saddle packs tags- a form-fitting, carbon-fiber clamshell with custom flotation pack and silicone gel under padding for both large and mid-sized whales

- Refined the 2006 deck mounted net gun deployment device and towed telemetry buoy into a field-ready system
    - Designed & fabricated a rope ascension module that could be used to shorten the buoy tow tether to the desired length
    - Redesigned the lasso to include sliding weights and low strength biodegradable materials (e.g. wool)
    - Designed and fabricated a user-programmable, potted, electronic timed release mechanism for removing the harness from the whale
    - Modified the telemetry buoy to integrate with the rope ascension module and to accommodate the new satellite/GPS tag package

- Conducted first field trials of net gun deployed towed telemetry tag on humpback whales in the Bay of Fundy

**RESULTS**

*Peduncle saddle pack tag*
Rev 4 of the deployment armature has been constructed. This unit uses a horizontally mounted piston that is pneumatically powered using a small $CO_2$ cartridge rather than the compression springs used in earlier designs. The pneumatic system provides consistent power throughout the power stroke in a much more compact package than was previously attainable in Revs 2 & 3. A form-fitting, carbon-fiber clam-shell saddle pack was also constructed as a lighter alternative to the previous urethane saddle prototype and tested with the new armature. Initial tests were conducted on a full-scale fiberglass model right whale tail in the lab. The new armature concept showed promise when powered by hand, but at full speed, the inertia and power associated with such a large scale system led to numerous component failures. In an effort to reduce some of the power and strength requirements yet still test the concept, a smaller set of arms and a scaled down saddle pack were constructed (Figure 3). These new components were tested with the power unit from the Rev 4 armature on a model pilot whale peduncle molded from a cadaver. Although a cinching mechanism is still required, the scaled-down Rev 4 system was quite successful in latching the buckle around the peduncle.

Based on these tests, it was decided that development of the peduncle saddle pack tag and deployment armature would progress more rapidly if the initial system was designed around a smaller scale animal, such as a pilot whale or false killer whale. Reducing the size of both the saddle and the armature would make both devices more manageable on the end of a pole, increasing the probability of successfully deploying the device. Bow riding behaviors typical of some mid-sized species would also enable the use of shorter, more manageable cantilevered poles or plunger-type hand pole deployments. The use of smaller animals also makes it possible to conducted preliminary tests on both the saddle and the deployment armature on a captive animal in a controlled setting. Saddle fit, animal reaction to the saddle, chafe, performance of the attachment mechanism under high energy maneuvers (fast swim or breach), and success of the armature in deploying the belt can all be examined before taking the device into the field. This sort of controlled testing is not feasible with a large whale system. As such, starting on a smaller scale will greatly facilitate the tag development. The design can later be scaled up as needed for use with larger animals once the concept of the peduncle belt has been demonstrated as a viable tagging option.

*Net gun deployed towed telemetry tag*
Simultaneously to the development of the peduncle saddle pack tag for mid-sized whales, alternative tagging options for large whales were further explored. A net gun deployment system was developed back in 2006 as a means of remotely deploying a padded harness about the tail stock of a fluking whale as an attachment point for a towed telemetry buoy. The net gun and towed buoy had already undergone several years of prior development and were nearly ready for a field trial. This type of tag fits well with the goal of a medium to long-term attachment and was specifically designed for use on large whales. As such, the 2006 net gun system was refined into a field-ready device (Figure 4).

The first field trials of the lasso/towed buoy tagging system were conducted on humpback whales in the Bay of Fundy in August ‘09. As with any new tag design or deployment technique, there is a learning curve associated with determining the best approach and tag deployment tactics and subsequently evaluating the whale’s responses to the tagging event. Although there were no successful

tag deployments this year, the field effort was invaluable in gaining insights into whale behavior and response to a peduncle type tag.

Overall the net gun performed very well as a line throwing device and was easily adapted in the field to accommodate changes in lasso shape and dimension while still fully deploying the loop. The loop reliably opened to about 90% of its maximum dimension just before striking the water (Figure 5). However, the whales proved sensitive to the touch of the line and were quite adept at “ducking” the loop.

Prior to the field effort, it was anticipated that the whales would respond to the touch of a line on their peduncle or back with a high fluke out and accelerated dive forward and away from the boat. Instead, the typical response elicited was an extremely agile readjustment of posture in such a way as to suck the contacting portion of the body down and away from the line and to instantaneously abort the fluke out. If the tail was already out of the water and the line landed across the fluke blade or hooked on the trailing edge, the whales were quite adept at dislodging the line with a slight flick of the fluke tip. This fine motor control of each portion of their bodies provided them an effective means of “ducking” the loop. To counteract the whale's instinctive line avoidance behaviors, it was determined that shots should only be taken once the fluke tips were completely out of the water and the whale was committed to the fluke out.

The field work also revealed that lassoing is actually a 2 stage process. One must both encircle the tail with the line and then close the loop before the whale slips out. Initially, tagging attempts were made with a 24 x 20 ft rectangular loop, and the whale was approached from the rear. Video review of the tagging sequence indicated that the loop was fully deploying, but was too large relative to the whale to close quickly enough before the whale swam out of the loop. The lasso size was subsequently reduced to a 10 x 15 ft loop with a side approach to the animal. The side approach offered two advantages: 1) the tail presented a smaller target when viewed from the side rather than directly from the rear, reducing the lasso size required to clear the fluke tips, and 2) the whales were more tolerant of a vessel on their flank than directly behind the flukes. However, even with the smaller lasso on a high fluke out with the flukes fully encircled in the lasso, the whale was able to simply slip out the bottom of the loop before it closed (Figure 6).

During the design phase, it was assumed that the forward motion of the whale would be sufficient to passively close the loop around the peduncle as the whale swam away. However, in the field the whales exhibited a nearly vertical descent angle with very little forward motion. They were able to dive faster than the lasso could sink and could easy drop out the bottom of the loop. As such, the field work highlighted the need for an active quick cinching mechanism to draw the lasso down and catch the tail. Looking at the cowboy model, once the cowboy throws the loop and the lariat settles on the horns, he jerks his arm back in a whip-like motion that when combined with the horse sliding to a stop provides the quick cinch and prevents the cow from running through the loop. Video review of the whale tagging sequence suggests that on a high fluke out there is sufficient time to draw the loop closed before the fluke tips go under, and designs are currently being developed for a boat-mounted whip-arm and line retraction device.

Overall this season’s results suggest that the net gun shows real promise for a tag deployment device once a quick cinching mechanism is developed, and efforts are underway to develop such an active cinching system. The harness it deploys can then act as an attachment point for a low drag buoy housing a satellite/GPS package which is towed behind the whale.

## IMPACT/APPLICATIONS

It is anticipated that the peduncle belt (either as a saddle pack or towed buoy) will provide a versatile tag attachment platform that is applicable to many medium to long-term cetacean tagging studies. The system is designed to be easily adjustable to accommodate a wide variety of species (beaked whales to baleen whales), tag electronics packages (satellite/GPS location tags to multi-sensor data loggers with acoustic recording capabilities), and tag deployment lengths (weeks to months to years) to meet the desired experimental design. From long term migration pattern studies to controlled exposure behavioral response studies, the peduncle belt shows great potential as an alternative noninvasive, recoverable tag attachment platform.

## REFERENCES

Woodward BL, Winn JP, Moore MJ, Peterson ML. 2006. Development of a towed telemetry tag for tracking the long term movement of right whales at sea. Final Report to National Oceanic and Atmospheric Administration. NOAA Award #NA04NMF4720400. 18 pages.

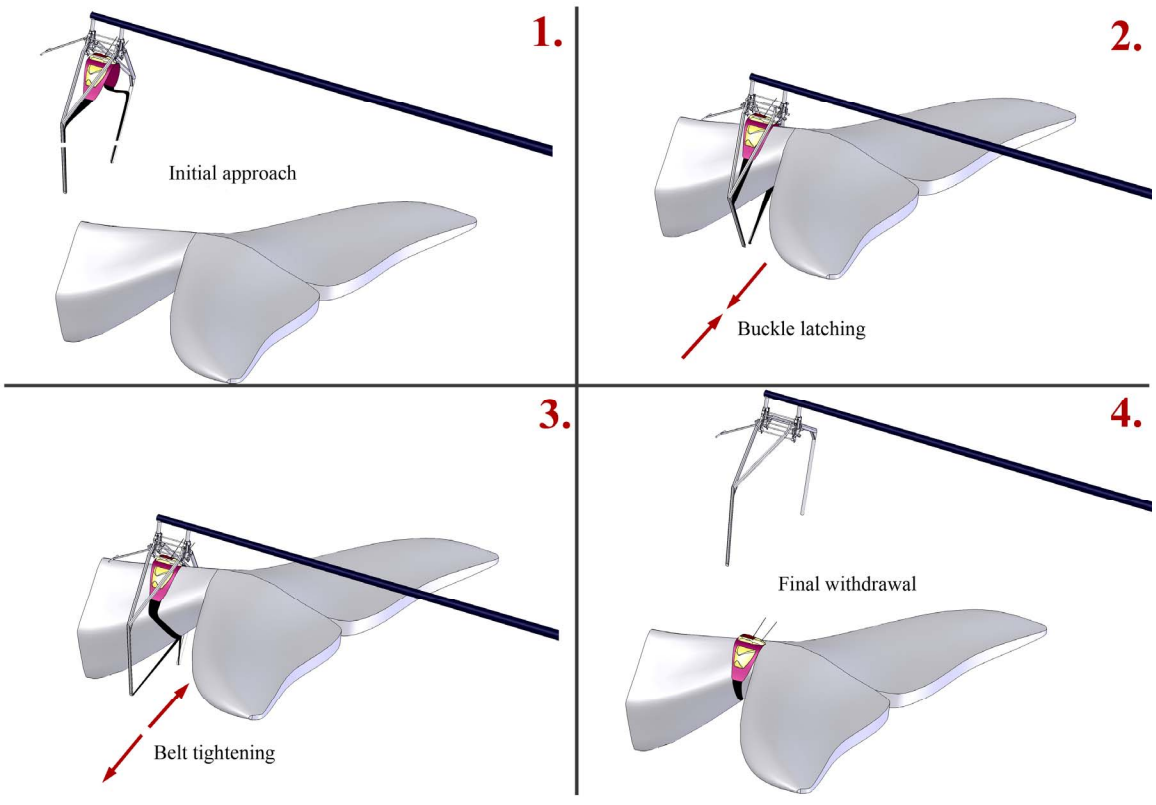


***Figure 1. Sequential stages of deployment for peduncle saddle pack tag.***

***Figure 2. Successful lasso attempt on a model right whale tail during on-the-water testing of the net gun deployment system.***

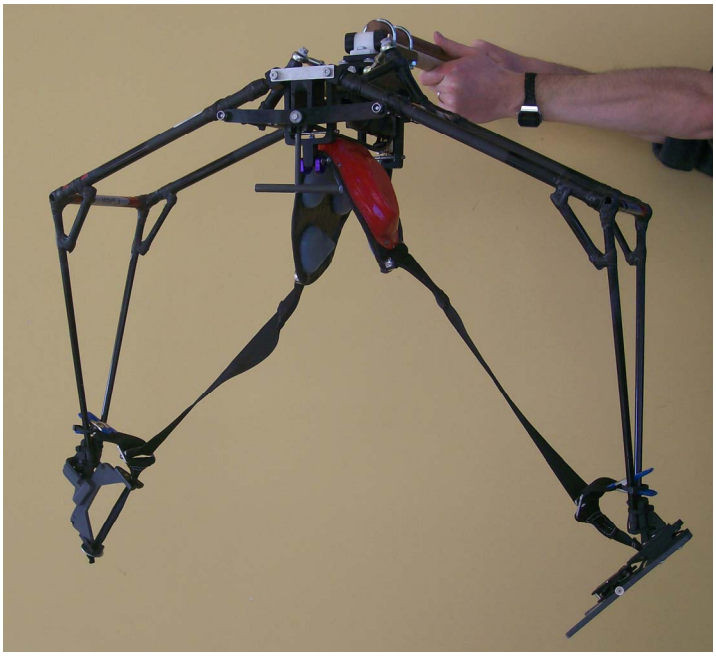

***Figure 3. Scaled down version of pneumatically driven piston deployment armature and peduncle saddle pack tag designed for a pilot-whale sized cetacean.***


***Figure 4. Net gun deployment device and towed telemetry buoy tagging system. The net gun throws a lasso around the tail of a fluking whale as a means of attaching the towed telemetry buoy. The rope ascension module pushes the buoy up the tow line and trims the trailing tether leaving the buoy trailing the whale at a distance of 60 ft.***

***Figure 5. Lasso deployment attempt on a humpback whale in the Bay of Fundy. Lassos typically opened to 90% of their maximum dimensions before striking the water.***


***Figure 6. Lasso encircling the tail of a humpback whale in the Bay of Fundy. Although the lasso completely encircled the tail, the whale was able to drop out of the loop before the lasso cinched down. The addition of a quick cinching mechanism is needed to actively pull the loop closed and catch the tail.***